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ABSTRACT

This study evaluates the relationships that exist between three types of visual and perceptual-motor tasks (coincidence-anticipation, tracking with rotary pursuit, and a unique two-dimensional discrete motor task) and investigates the nature of learning demonstrated by the subjects on each of the three tasks. Thirty male students were given 20 trials on each of the tasks. A correlation matrix of task variables was computed and learning curves plotted. Results indicated that an individual's ability to perform one visual cue perceptual-motor task is relatively unrelated to performance on another task. Positive learning was demonstrated on the two-dimensional tasks (pursuit rotor and light panel), but the slight learning progress demonstrated during the early trials of the coincidence-anticipation task was almost negated during the final five trials. (Author)

LEARNING AND RELATIVE PERFORMANCE ON TWO AND THREE DIMENSIONAL

VISUAL CUE PERCEPTUAL-MOTOR TASKS

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INTRODUCTION

In many physical activities, correct execution of a skill is dependent upon the interception of a moving object at a precise point. The accuracy of an interception response is dependent on the ability to judge the arrival time of a moving object as well as the capacity to execute the intercept movement. Thus, the ability to affect a motor response coincident with the arrival of an object at a designated point of interception has been termed "coincidence-anticipation". In spite of the possible implications for motor performance, the nature of coincidence-anticipation has received little concentrated study. Research by Hicks and Bates (6), Slater-Hammel (8), Belisle (1), Grose (5), Schmidt (7), Stadulis (9), Glad and Dunham (3) (4), constitute the most recent efforts in this direction. As worthwhile as such studies are, the relationship of coincidence-anticipation to other perceptual-motor tasks that are also dependent on visual cues has not yet been examined. In commenting on the visual-perceptual judgments involved in dynamic motor skills, Cratty stated that "Research contrasting the ability to deal with two-dimensional and three-dimensional space and motor performance are notably lacking." (2)

Purpose

The purposes of this study were (1) to evaluate the relationships that exist between three types of visual cue perceptual-motor tasks, (coincidence anticipation, tracking with rotary pursuit and a unique two-dimensional discrete motor task) and (2) to investigate the nature of learning, if any, demonstrated by the subjects on each of the three tasks.

Apparatus

COINCIDENCE-ANTICIPATION

As illustrated in Figures I, II, III, IV & V, the coincidence-anticipation apparatus used in this study consisted of five parts: a stable portion, a mobile portion, switches, electronic controls and timers.

The stable portion was developed by the investigator from two pieces of metal conduit, welded side by side horizontally and formed into a rectangle with round corners. The length is sixteen feet eight inches and the width thirty inches. The stable track is suspended horizontally form the ceiling of the Washington University motor learning laboratory and stabilized by guy wires. Five feet of one end of the track is sloped upward forty degrees from the horizontal.

The mobile portion of the apparatus is a seven-wheeled car (see Figure II) which runs on the track as though it were a monorail. The body of the car consists of mountings for the wheels, braces, and an outer protective covering of plastic. Four of the wheels, two on each side contact the track at an angle of sixty-five degrees above the horizontal. Two other wheels, one on each side, contact the track at an angle fifteen degrees below the horizontal. These wheels are all ball bearing wheels, two inches in diameter. A seventh wheel, one inch in diameter is mounted on the car just under the track and serves as a stabilizer when the car is pushed into the elevated position just prior to each trial.

A twelve inch rod, with a red styrofoam ball three inches in diameter attached to its end, is suspended from the bottom of the car. Protruding horizontally from the top of the car is a two inch piece of aluminum which serves to trip microswitches at three points on the track. The car is pushed up the elevated portion of the track by means of a four foot rod

which hooks into a 1/4 inch machine bolt protruding from the bottom of the car. (Figure I). When the car is released it is propelled by gravity and easily travels the length of the track, including the curve in less than two seconds. As the car returns to the starting position it passes a safety latch which prevents the car from reversing its direction.

Microswitches are located at three points on the track: one at the foot of the elevated portion of the track on the descending side, the second just before the turn nine feet six inches from the first microswitch, and the third is located seven feet around the turn from the second microswitch. The second and third microswitches are marked by yellow, triangular flags, six and one-half inches long by four inches at the base and suspended thirteen inches below and outside the track. The front edge of the ball coincides with the front edge of the flags as the second and third microswitches are tripped.

The microswitches are in circuit with an electronic control panel which operates a system of four .01 timers. Two of the clocks are started by the car tripping the first microswitch; one is turned off by the second microswitch while the second is turned off by the subject, operating a telegraph key. The remaining two clocks are started at the second microswitch, one is turned off at the third microswitch and the other by a subject operating a second telegraph key. The apparatus therefore permits two recordings (to and fro) of the real time versus the subject's estimated time on each trial. The electronic controls permit continuous operation of the apparatus without resetting the microswitches.

The propulsion car and track, as well as the operator who starts the car, are hidden from the view of the subject by means of curtains. (Figure IV) This permits the subject to concentrate on the movement of the ball. Thus, the subject has the sensation of seeing a ball move in space -- approaching

the subject on his right, passing the first flag, reversing its direction and passing the second flag as it travels away from him.

Since the telegraph keys are mobile, it is possible to test subjects at a variety of distances away from the apparatus. For this experiment the keys were located on a table ten feet from the lower end of the track. The center of the first key was twelve feet from the first flag and the second key was fourteen feet from the second flag. The keys were thirty-six inches apart, center to center.

TWO-DIMENSIONAL VISUAL CUE

The two-dimensional eye-hand coordination testing devise was designed by the investigator to create a condition which requires rapid and accurate responses to visual cues. As shown in Figures III & VI, the apparatus consists of four components: a testing panel, a supporting stand, a control panel and a 1/100 of a second timer.

The square testing panel, 30 x 30 x 3" is contructed of reinforced aluminum on which eleven light-up switches are distributed to cover all quadrants. The height of the panel is easily adjustable as its slides on the support frame and locks in place by means of spring latches. A short lever extends horizontally from one side of the panel and serves as a means of standardizing height of the panel to the height of the subject.

The electrical circuitry is arranged so that an initial switch is lighted which must be depressed to deactivate the light. Such action causes a second switch to be lighted which must be depressed and so on until all the switches have been touched. The switches are quite sensitive and need only to be slightly touched in order to function. Three distinctly different patterns can be used to prevent the possibility of the subject falling into a standard response and thus he has to rely on the visual cue of the newly

activated light. Each of the three patterns requires the subject to cross the midline several times as well as move in a vertical plane.

The testing panel is connected to the control panel by means of a twelve foot 24 strand flexible cable. The control panel houses the power supply and all the electronic components. Externally the control panel has a 115V input lead, a fuse, an on/off switch, a reset switch, a three position pattern switch a clock jack and a repeat switch. (The latter was not used in the present investigations, but provides the option of having a subject continue a test indefinitely.) The clock jack has leads which activate a 100th of a second timer as the first light-up switch is touched on the testing panel and deactivates the timer when the last light-up switch is touched.

PURSUIT ROTOR

The pursuit rotor used in this study was manufactured by the Pentagon Instrument Company of Syosset, L.I., New York. A circular pattern seven inches in diameter and a speed of rotation at 80 RPM was utilized for the tracking test.

All .01 second timers were manufactured by Lafayette Instrument Company and a "Hanhart" stop watch was used in conjunction with the tracking test.

Subjects

The subjects for this study were thirty male student volunteers at Washington University, St. Louis, Missouri. All testing was conducted during September and October, 1973.

Procedures

Upon entering the labortory the subjects were randomly assigned to one of the six possible performance orderings. They were given standard

instructions on each of the three tasks as they were encountered. When the experimenter and the subject were satisfied that the subject understood the nature of the task the experimenter commenced testing. Each trial was preceded by the experimenter saying "Ready," and the subjects concurrence. The subjects had twenty trials on each of the three tasks and in all cases used only his preferred hand.

The trial procedure for the coincidence-anticipation task were as follows: The subject stood behind the table on which the telegraph keys were located with his preferred hand ready to hit the key to his right. (see Figure V) After the subject indicated his readiness, the car was released by the experimenter and it traveled down the track at an average speed of 10.7 feet per second. Three scores were obtained for each trial based on the absolute difference between the times recorded on the "real time" and the subject "estimated time" clocks, the scores were: difference to, difference fro, and combined difference. Inter-trial periods were the length of time required to record the results and reset the clocks, approximately 15 seconds.

The procedure for the two dimensional light-up panel was initiated by first adjusting the height of the panel to the subject. The subject then positioned himself approximately an arm's length away from the panel. (see Figure VI) When the subject indicated that he was ready, the experimenter touched the "reset" switch on his control panel which activated the first of eleven "light-up" switches. A .01 second timer was activated as the subject depressed the first switch and continued running until he completed the entire pattern. In an effort to involve precision as well as limb speed the subjects were instructed to use only the index finger to depress the switches. A different pattern was used for each trial thus requiring the subjects to rely on the lights as cues for their motor responses. The score was the actual

time required to complete the trial. The intertrial periods were always between 10 and 15 seconds which was slightly longer than it took to record the subject's score and change the light pattern.

On the pursuit rotor task, the subjects were instructed to hold the cord in their non-preferred hand as it had been previously noted that a waving cord could effect the stylus pattern. After the subjects indicated his readiness, the experimenter said "go" and simultaneously started a stop watch. At the command "stop" the subject quickly moved the stylus away from the rotating light and kept the photocell-end pointed toward the opaque glass surface. Each trial lasted for 15 seconds and the trial recorded as the time on target. As in the other tasks the inter-trial was from 10-15 seconds.

RESULTS

Mean scores were computed for all subjects on each of the tasks by blocks of five, i.e., the mean of the first five trials, second five trials, etc. Thus, there were twenty variables as follows: Coincidence-Anticipation (to), 4; Coincidence-Anticipation (fro), 4; Coincidence-Anticipation (both), 4; Pursuit Rotor, 4; Light-up Panel, 4. The group means and standard deviations appear in Table 1. The interrelationships of the subjects' performances on the three tasks were computed by using a Washington University 360 Computer Library program titled "STAT" which furnished a correlation matrix of the twenty variables. The amount of generality and specificity contained in each correlation was obtained by employing the mathematical definition, $r^2 + k^2 = 1$ (coefficient of determination plus the coefficient of non-determination equals one). These results of the final five trials appear in Tabel II.

The trial-block means were plotted to illustrate the subjects' learning curves and are presented in Table III. It is interesting to note that

TABLE I

Mean Score and Standard Deviation, Thirty Subjects in Blocks of Five

Variable	Mean	Standard Deviation
CA(to) 1	.0715	.0306
CA(to) 2	.0704	.0274
CA(to) 3	.0659	.0386
CA(to) 4	.0697	.0375
CA(fro) 1	.0738	.0303
CA(fro) 2	.0637	.0397
CA(fro) 3	.0606	.0431
CA(fro) 4	.0646	.0383
CA(both) 1	.1452	.0482
CA(both) 2	.1341	.0588
CA(both) 3	.1265	.0728
CA(both) 4	.1344	.0621
PR 1	4.0941	1.9174
PR 2	4.8591	2.0935
PR 3	5.3767	2.1145
PR 4	5.8831	2.2638
LP 1	7.4797	.6552
LP 2	7.1341	.5768
LP 3	6.9537	.6921
LP 4	6.7679	.6573

TABLE II

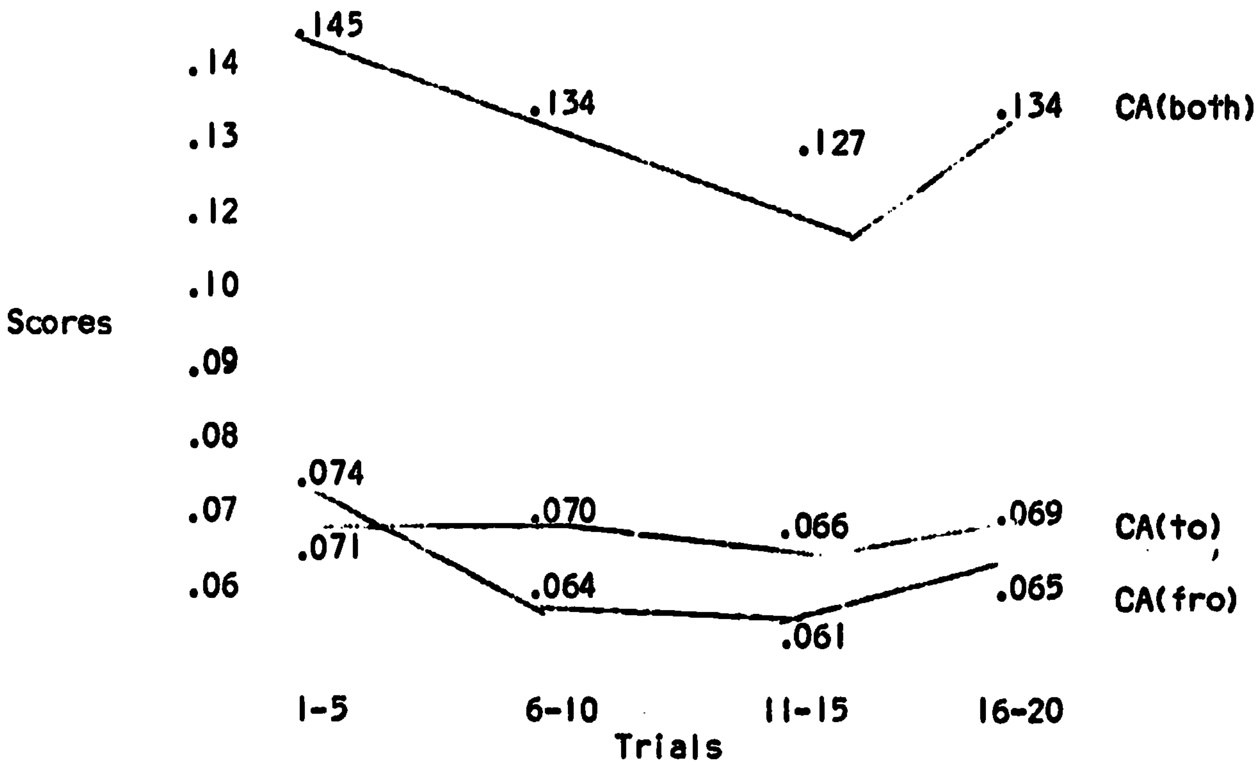
Intercorrelations, Task Specificity and Generality, Last Five of Twenty Trials for Thirty Subjects Performing Three Perceptual-Motor Tasks

	r	r^2	K^2
CA(to) - CA(fro)	.3413	.1155	.8845
CA(to) - CA(both)	.8150	.6642	.3358
CA(to) - PR	-.2840	.0805	.9195
CA(fro) - LP	.0494	.0024	.9976
CA(fro) - CA(both)	.8227	.6768	.3232
CA(fro) - PR	-.2847	.0811	.9139
CA(fro) - LP	-.0167	.0003	.9997
CA(both) - PR	-.3452	.1192	.8808
CA(both) - LP	-.0413	.0017	.9983
PR - LP	-.0352	.0012	.9988

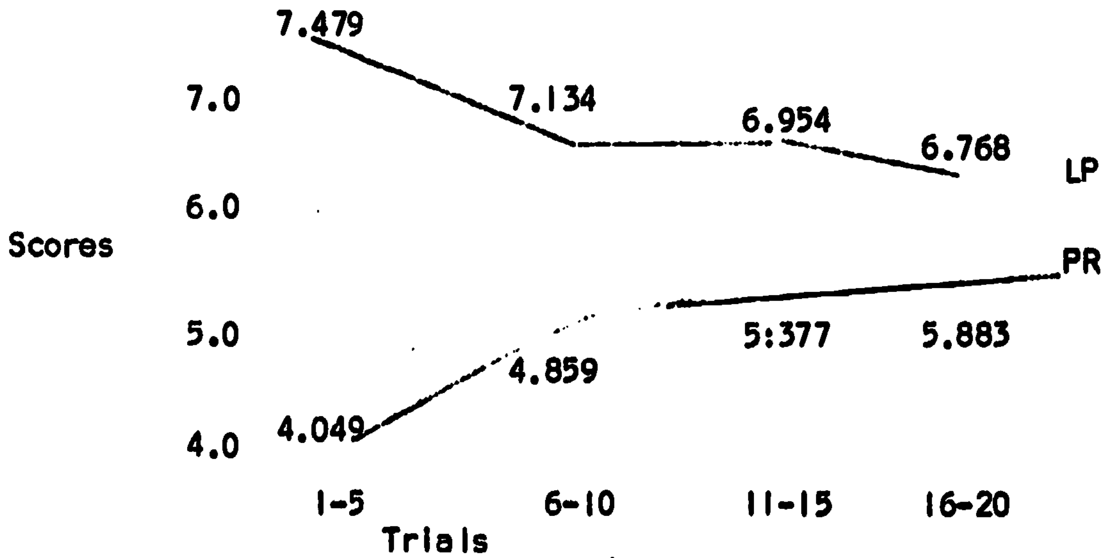
TABLE III

Learning Curve Plots

Coincidence-Anticipation



Light-Up Panel and Pursuit Rotor



performance on the coincidence-anticipation task regressed slightly after making only a moderate advance. This might be explained as the result of a carelessness or even boredom that could be related to a lack of extrinsic feedback.

The results of this study would seem to indicate that an individual's ability to perform one visual cue perceptual-motor task is relatively unrelated to his performance on another task. This is certainly consistant with the theory of task specificity, but calls to question some of the generalizations that are frequently made regarding visual motor performance. For example, some vision tests often associated with obtaining a drivers license might be as unrelated to driving ability as were the tasks in this study.

The common variance that was demonstrated between the coincidence-anticipation (to)-(both) and (fro)-(both) should be expected. On the other hand, the slight correlation between the (to) (fro) variables would make it difficult to assume that the subjects exhibited a general coincidence-anticipation trait as opposed to specific task abilities.

As would be expected, considerable variability was noted between individual performances on all three tasks.

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